

REMARKS

The following remarks are responsive to the Office communication, dated September 12, 2007, wherein pending Claims 24-41 were finally rejected. A Notice of Appeal was filed on March 12, 2007.

Claim 24-41 are canceled.

The pending claims are new Claims 42 - 53. As explained below, no new matter is introduced. Indeed, all of the now pending claims enjoy the benefit of the November 29, 2002 priority document, GB 0227891.9.

Each of the Examiner's objections and rejections is discussed separately below.

A Notice of Allowance is respectfully requested.

Interview Summary

To comply with MPEP, Section 713.04, as relates to the Interview with the Examiner, dated March 21, 2007, two references were discussed (JP 2002-228,307 and US Patent No. 6,606,868 ("Powell")). Applicant agreed to file a request for continued examination and provide data comparing the claimed compositions to Powell.

Amendments to the Specification

The new paragraph following paragraph [0022], introduces no new matter.

The language is disclosed in and supported by Claims 1-3 as filed on August 4, 2003 and in part, by paragraph [0009] and fully supported by the November 29, 2002, priority document at page 2, lines 18, and at Claims 1-2.

Amendments to item (30) represent the correction of the typographical error in the number for the November 29, 2002, priority document.

A replacement Table 2 is provided to correct obvious typographical errors. The corrections are supported by Table 2 as filed on November 29, 2002.

All of the claims now pending enjoy the benefit of the November 29, 2002 priority document.

Amendments to the Claims

The previously rejected Claims 24-41 are now canceled. The new claims reflect amendments to the subject matter of the canceled claims.

Independent claims are Claims 42, 43, 44 and 45 and each is directed to a composition.

Claims 46 -53 all depend on either claim 42 or 43.

The support for each claim is discussed separately below.

Independent Claim 42 differs from now canceled Claim 24 by eliminating component (d) and changing the transition phrase from “comprising” to -- consisting of --.

Support for the 3 wt % to 4 wt. % of isobutane is found in the August 4, 2003 United States application in as filed claim 2 and also in the November 29, 2002 priority document in claim 2.

Independent Claim 43 is similar to Claim 42 and adds a component (d) which is a lubricant selected from the recited group. Support for the lubricant language is found at in paragraph [0026].

Independent Claim 44 is similar to Claim 42 and adds a component (d) which is lubricant selected from the recited group (support at paragraph [0026]) and component (e) which is an additive selected from the recited group. Support for the additive language is found at in paragraph [0027].

Independent Claim 45 is similar to Claim 42 and adds a component (d) which is an additive selected from the recited group, which is supported by the description at paragraph [0027].

Dependent Claims 46 and 47, having 3.5 wt% isobutane, are supported by the disclosure at paragraph [0048].

Dependent Claim 48, having above 64% up to 66% by weight of component (a) is supported by the disclosure at paragraph [0019].

Dependent Claim 49, having about 28% to about 32% by weight is support by the disclosure at paragraph [0020].

Dependent Claims 50 and 51 are directed to the refrigeration apparatus as disclosed at paragraph [0012].

Dependent Claim 52 is support by the disclosure at paragraph [0029].

Dependent Claim 53 which depends on Claim 43 and is directed to the specific lubricants recited at paragraph [0026].

Double Patenting

Now pending claims exclude the component (d) “no more than 5% another fluorocarbon component” as recited in rejected Claims 24 and 30 (now canceled). Applicants’ submit that the Double Patenting rejection should be withdrawn in view of this amendment.

35 U.S.C. § 112, First and Second Paragraph

The Examiner rejected the claims as having new matter with respect to the recitation of 3-4 % isobutane and about 64wt. % to about 66 wt. % of component (a) pentafluoroethane. The claims have been amended to avoid the issues raised by the Examiner.

With respect to the recitation of component (c) being from 3 to 4 wt. %, the above amendment to the specification provides the literal support and no new matter is being added as such matter was in both the August 4, 2003, filing and the November 29, 2002 priority document. As explained above, no new matter is introduced into the application by the above amendments. Applicants submit that the rejection and objection can be withdrawn.

35 U.S.C. § 103(a)

The Examiner rejected Claims 24 - 41, under 35 U.S.C. § 103 (a) as being obvious over U.S. Patent No. 6,606,868 (the ‘868 patent) and JP 2002-228,307 (the “JP reference”).

For the reasons explained below, Applicants believe that these references fail to teach or suggest to one of ordinary skill in the art (whether considered separately or together) to select the compositions of now amended Claims 42-53.

Moreover, as discussed below, the ‘868 patent actually teaches away from successfully selecting the claimed compositions having specific ranges of mixtures of R125, R134a and R600a in the now presented independent claims.

In addition, the specific ranges of mixtures now claimed possess unexpected advantageous results, over the compositions disclosed by the ‘868 patent, including the fact that they are non-flammable. Each reference is discuss separately below.

In addition to the discussion of each reference, attached is the declaration of Dr. Donald Bivens. Dr. Bivens' declaration, a detailed technical analysis of the data illustrating the unexpected results, including the non-flammability vapor leak test results of the now claimed compositions in contrast to the vapor leak test results for the '868 patent composition (and the determination of flammability). The non-flammability of now claimed compositions is an unexpected advantage over the compositions taught by the '868 patent.

The U.S. Patent No. 6,606,868

Applicants submit that the Examiner's recited ranges of R125/R134a/isobutane (Office communication paragraph 9) does not make the selection of the precise high and low limits of the range as now recited in the amended claim obvious.

The Examiner recited passages from the '868 patent disclosing compositions having: 64-76 wt.% pentafluoroethane, 24-32 wt. % 1, 1, 1, 2-tetrafluoroethane, and hydrocarbon additives of up to 10%. *Office Communication*, dated September 12, 2006, at paragraph 9. The Examiner alleges that the '868 patent teaches that one of the hydrocarbon additives can be isobutane, in view of the occurrence of the term "2-methylpropane" in the '868 patent's specification at column 4, line 39. *Id.*

Applicants respectfully disagree with certain aspects of the Examiner's characterization of the '868 patent and disagree with his conclusion that, in late 2002 one of ordinary skill in the field of refrigerant formulation, would have understood from the '868 patent to formulate a composition having 3-4 weight % isobutane, 62-67 weight % R125, and 26-36 weight % R134a. In short, the '868 patent fails to teach or suggest the compositions recited by the Amended Claims.

There are Too Many Possible Formulations Within the '868 Patent's Disclosure
to Suggest the Compositions Now Claimed.

In order to illustrate that the '868 patent discloses a broad spectrum of possible formulations, Dr. Bivens determined¹ the number of possible different formulations that could have been created from the '868 patent's disclosure of blends comprising:

64-76 wt.% pentafluoroethane,

24-32 wt. % 1, 1, 1, 2-tetrafluoroethane, and

0-10 wt. % of 18 different possible specifically
disclosed hydrocarbons or mixtures of certain
selected hydrocarbons.²

While refrigerant formulations are often determined and specified in fractional weight % of 0.1 %, Dr. Bivens used an increment of 0.3 weight % for each of three components to determine the number of possible different formulations disclosed and to keep the total within calculation limit of the Minitab® statistical software. With the requirement that each formulations must add to 100 weight %, Dr. Bivens determined that over 25,000 different formulations of two hydrofluorocarbons (R125 and R134a) and 18 specific hydrocarbon additives are possible.

Dr. Bivens made additional calculations using an increment of 0.5 weight % for each of the three types of components, limiting to those combinations that added up to 100 weight %, and determined that it was possible to formulate over 5,000 different compositions. Both numbers (whether 25,000 or 5,000) are too large to provide any meaningful teaching or suggestion of any specific refrigerant compositions, especially one using isobutane, R125 and R134a as set forth in the amended claims.

For contrast purposes, if the formulations of the amended claims were limited to the 3 components that total 100%, and using a 0.3 wt. % increment, the total number of possible

¹ This determination was made using statistical calculation software that is commercially available and marketed under the name Minitab®, a registered trademark of Minitab, Inc.

² The explicit teachings of the '868 patent at column 3, lines 38 -47 and the Example 7, and the claims, are to use certain hydrocarbons individually and that only a few can be used to create mixtures. The '868 patent recites the following 18 possible hydrocarbon additives: 2-methylpropane; 2, 2 – dimethyl propane, butane, pentane, 2-methylbutane, cyclopentane, hexane, 2-methylpentane, 3-methylpentane, 2,2-dimethylbutane, methylcyclopentane; and seven mixtures of hydrocarbons: n-pentane + cyclopentane + iso-pentane; and n-pentane + iso-pentane; pentane + butane; cyclopentane + butane; n-pentane + cyclopentane; iso-pentane + cyclopentane; and butane + isopentane.

different formulations is only 98; and if a 0.5 wt % increment, the number is 33. *See* Bivens' Declaration at paragraph 3.1.

The '868 Patent Explicitly Teaches that Isobutane is not an Acceptable Hydrocarbon

Even if one of ordinary skill in the art of formulating compositions had unlimited resources (money, infinitely powerful computers, lab personnel, time, equipment, materials), the '868 patent does not teach the use of isobutane (despite the recitation of 2-methyl propane). Indeed, the '868 patent teaches away from the use of isobutane in refrigerant formulations. Thus, when the large number of possible refrigerant formulations is juxtapositioned with the explicit teachings of the '868 patent, one of ordinary skill would never have been taught to use isobutane in the timeframe of circa 2002.

The explicit teachings and fair suggestions of the '868 patent are to create a refrigerant composition that includes a saturated hydrocarbon or mixtures of hydrocarbons selected from those "boiling in the range of -5 °C to + 70 °C." *See, e.g.,* the '868 patent at the Abstract (front page); col. 2, lines 45-46; and Claim 1 at column 15. Moreover, the '868 patent states that the hydrocarbon additive preferably has a boiling point in the range of 20°C to 40°C. *See* the '868 patent at column 3, lines 43-44. Isobutane has a boiling point of -11.7°C. Thus, it appears that the inventors named on the '868 patent erroneously listed 2-methyl propane in the list of hydrocarbons that they believed boiled at temperatures between -5 °C to + 70 °C.

Indeed, all of the saturated hydrocarbons listed in the '868 patent (with the sole exception of 2-methylpropane) have a boiling point well above the lower boiling point limit of - 5.0°C. The fact that the '868 patent inventors expanded the recited lower end of range to -5.0°C from the boiling point of -0.5°C of butane, is evidence to one of ordinary skill of a deliberate decision to exclude all hydrocarbons boiling lower than the -5.0°C. Viewing the named inventors of the '868 patent as knowledgeable in their field, the inclusion of 2-methyl propane appears to have been an inadvertent error.

The specification of the '868 patents provides other evidence that the listing of 2-methyl propane was an inadvertent error. The only butane mentioned outside of the list at column 3, is the use of the word "butane" (which means n-butane, not isobutane, to one of

ordinary skill in the art)³ and then in mixtures with a pentane. *See*, the ‘868 patent at column 3, lines 52 – 59; column 11, lines 7-9; column 12, line 14 and Table 7 and claims 9-12 and 20. Table A lists the hydrocarbons considered by all of the Examples reported in the ‘868 patent with their boiling points.

Table A
Hydrocarbons Used in Examples of the ‘868 Patent

Example	Hydrocarbon(s)	Boiling Point
1	4% pentane	36°C
2	4% pentane	36°C
3	4% pentane	36°C
4	4% pentane	36°C
5	4% pentane	36°C
6	4% pentane	36°C
7	2% pentane	36°C
	1% isopentane + 2 % n-butane	28°C & -0.5°C

The selection of the n-pentane and iso-pentane in the ‘868 patent Examples indicates that these inventors believed that the middle of the -5 °C to +70 °C range was likely to produce the fruitful area of investigation. That the middle of the of -5 °C to +70 °C range is

³ *See* the term “Butane” means n-butane, and excludes isobutane. *See* Hawley’s Condensed Chemical Dictionary, 12th Edition, p.177, “Butane (n-butane) . . . bp -0.5C . . .”. A copy is attached hereto as Bivens’ Declaration, Exhibit C.

where the '868 inventors believe the best compositions could be formulated is explicitly stated in the '868 patent at Column 3, lines 44-46, stating:

Use of n-pentane, cyclopentane, iso-pentane and mixtures thereof is preferred. Use of n-pentane, isopentane and mixtures thereof is especially preferred.

All three of the pentanes mentioned above have boiling points at temperatures in the middle portion of the recited -5 °C to +70 °C range, at +36°C, +49, and +28°C, respectively.

Thus, Applicants' submit that the totality of the teachings of the '868 patent reference is that it teaches away from using a hydrocarbon having a boiling point below -5°C. At best, the '868 patent teaches that if n-butane (b.p. -0.5°C) is used, it should be mixed with isopentane. There is nothing in the '868 patent that teaches or suggests that isobutane would be useful alone, or in combination with isopentane, in a refrigerant formulation, let alone in a composition having: 3-4 wt. % isobutane with 62-67 wt. % R125 and 26-36 wt. % R134a.

The '868 Patent has Inconsistent Teachings about the Required Amount of R125

A review of the '868 Examples 1-3 and 7 (with corresponding Tables 1-3 and 7) reveal inconsistent teachings about the required amount of R125 in refrigerant formulations to replace R22. Examples 1-3 calculations would lead the reader to use 61.5% R125 to 73% R125 (with R134a and 4% pentane), while Example 7 performance test data and inventor data analysis (column 12) would clearly lead the reader to use less than 60.5% R125.

Beginning with Examples 1-3, the inventors of the '868 patent formulated compositions to replace R22, and the compositions

were evaluated using [unidentified] standard refrigeration cycle analysis techniques in order to assess their suitability as retrofit replacements for R22. . . The pentane was present at 4% by weight based on the total weight of the R125/R134a blend. To simplify the calculation this small amount of pentane was omitted.

See column 4, lines 53-54 and 63-65.

Likewise, the inventors of the '868 patent teach that the compositions having exhaust pressures more than 2 bar above that of R22 were unacceptable (column 5, lines 37-38), and compositions having refrigerant capacity less than 90% of that of R22 were unacceptable (column 5, lines 39-40; column 6, lines 33-36, and column 7, lines 31-33).

With these criteria, the '868 patent's calculated 'acceptable' compositions had R125 amounts of 64% and 76% (from Examples 2 and 3), and 56%, 64%, and 76% (from Example 1), even though the Example 1/Table 1 numbers show the calculated capacity of the 56% R125 composition is less than 90% of that of R22. Based on the Example 1-3 calculations, the reader is taught to expect that acceptable performance with compositions (with the 4% pentane added) of 61.5% R125 + 34.5% R134a + 4% pentane and 73% R125 + 23% R134a + 4% pentane. (R125 and R134a amount adjusted to include 4% pentane.)

However, turning to the actual, rather than calculated data, the Table 7 system testing data show that "Blends # 3, 5, and 6 provided the closest similarities to R22 operational temperatures and pressures". *See* column 12, lines 15-16. Yet, Blends # 3, 5, and 6 had R125 amounts of 55%, 45%, and 55% -- all below the 64 wt% indicated by Examples 1-3.

The icing experienced with Blends # 1, 2, and 4 "required addition of up to 20% refrigerant to prevent icing of the evaporator". *See* column 12, lines 1-2. Blends # 1, 2 and 4 have R125 amounts of 60.5%, 64%, and 70%, very near the range of R125 that Examples 1, 2, and 3 teach to be acceptable amounts of R125. Thus, Table 7 performance test data teaches away from using compositions having 60.5% or more R125, and teach that the preferred amounts of R125 are in the range of 45-55%; (which is opposite to the teachings of Tables 1-3), to avoid icing problems.

After reading these sections and examples of the '868 patent, one of ordinary skill in the refrigerant formulation field would have learned several things:

(1) that blends matching R22 operational temperatures and pressures did not have the required cooling capacities as calculated by the '868 inventors,

(2) if one matches 90% of the R22 cooling capacity, one should expect icing of the evaporator while in operation, or that one must add up to an additional 20% refrigerant to prevent icing, and

(3) one should avoid compositions having 60.5% or higher R125 if seeking an R22 replacement refrigerant mixture.

While achieving 90% of the R22 capacity is taught by the '868 patent to be a minimum requirement in identifying an acceptable blend, nothing in the '868 patent teaches how to formulate a blend with 90% of R22's cooling capacity while achieving the balance of performance properties required for an acceptable R22 alternative. In short, this reference is non-enabling to any invention, let alone the compositions as now claimed.

If the above information from Examples 1, 2, 3, and 7 were not enough to discourage one of ordinary skill from using a composition having more than 55 wt.% of R125 (certainly not more than 60.5 wt%), the other '868 patent Examples (4-6) also teach away from formulating a composition have 62-67 wt % R125. In Examples 4-6 of the '868 patent, various blends were used as an extender refrigerant in systems containing R22, and all examples use compositions having less than 62% R125. While various levels of usefulness as extenders were observed in the different systems, none used isobutane and none used more than 61.5 wt% of R125. *See* column 7, lines 53 to column 8, line 33 (using R125 in amounts of 61.5 wt % and 42.3 wt % R125, and 4% pentane).⁴

The '868 Patent Teaches Compositions that can become Flammable

An additional requirement essential to a successful formulation of an R22 alternative is non-flammability in the as-formulated compositions and in any changed composition should there be vapor leakage of refrigerant from a storage container or refrigeration/air conditioning equipment. To determine the flammability of the '868 patent compositions, Dr. Bivens requested vapor leakage and flammability tests to be performed at DuPont laboratories by personnel who run the same tests for DuPont formulated compositions. The resulting data (Exhibit A to Bivens' Declaration) show that the '868 patent compositions tested were determined to become flammable under vapor leakage conditions as prescribed by ASHRAE Standard 34-2004, addendum p.⁵ Dr. Bivens concluded that if submitted for

⁴ In Examples 4-6 of the '868 patent, the amount of pentane used in each test composition is expressed "as 4% by weight based on the *total weight of* the R125/R134a blend." *See, e.g.,* col. 4, lines 63-64; and column 7, lines 52-53. Thus, when the '868 patent recites a compositions 64 wt % R125 : 36 wt % R134a with 4% pentane, the actual amount of R125 and R134a in the test composition was 61.5 wt. % R125: 34.5% R134a. That is, 100% - 4% pentane = 96% (R125 + R134a) or $(96 \times .64) + (96 \times .36)$. Thus, $4 + 61.5 + 34.5 = 100\%$.

⁵ All flammability testing was done in accordance with ASHRAE Standard 34-2004, addendum p and ASTM E681. The Flame Boundary Plot, of Exhibits C and D, was collected by DuPont over many years, including

ASHRAE classification, the compositions of Exhibit A would be expected to receive a safety classification of flammable. This classification would result in significant use restrictions in applications associated with the general public, such as in homes, commercial buildings, and transportation.

Withdrawal of the rejection based on the '868 patent is requested.

The JP 2002-228,307 Reference

With appreciation to the Examiner for his summary of the JP reference (Office Communication, paragraph 10), Applicants respectfully disagree with the Examiner for several reasons. As an initial matter, the JP reference is directed “[t]o providing a refrigerant filling method of a mixed refrigerant for replacing R22, R502, or R12, along with a filled apparatus.” JP Translation attached at p.1, Abstract and Claim 1. Also at paragraph [0014], the JP Reference states that:

the present invention is usually non-azeotropic mixed refrigerants . . . filling the nonflammable hydrofluorocarbon refrigerant (c) first, then filling the mixed refrigerant consisting of the [other] hydrofluorocarbon refrigerant (a) with high azeotropy and the flammable hydrocarbon (b)

See also paragraphs [0018] (“not only is filling work complicated . . . according to the present invention, the refrigerants can always be filled with a constant [] composition..); [0019] (“the present invention provides a mixed refrigerant filling method is filled in a refrigerant container”); and [0020] (“the refrigerant container is a refrigeration cycle apparatus).

While the JP reference discloses a wide variety of refrigerant mixtures that may benefit from the mixing procedures disclosed by the JP reference, the inventors in the JP reference neither teach nor suggest anything about how to go about selecting specific formulations.

In addition to discussing a method of mixing, the JP reference discusses a large number of possible compositions. In fact, the disclosure is so broad that the large number of possible formulations teaches nothing about selecting those that would be advantageous. To

experiments performed and data collected after 2003. This chart was not made available to the public by DuPont until about June 2006.

illustrate this point, Dr. Bivens, paragraph 4.1, determined the number of possible formulations that could have been created from the JP reference's disclosure of blends comprising the recitation summarized by the Examiner, which is

55-80 weight % pentafluoroethane,
20-40 weight % 1, 1, 1, 2 – tetrafluoroethane, and
1-9 weight % isobutane.

Using an increment of 0.3 wt. %, and limiting the possible formulations to those that add up to 100%, the number of different possible formulations is over 4,000;⁶ if the increment is 0.5 wt. %, the number is over 1300. For contrast purposes, if the formulations of the pending claims were limited to the 3 components that total 100%, and using a 0.3 wt. % increment, the total number of possible different formulations is only 98; and at a 0.5 wt. % increment, the number is 33.

Even if the specific compositions described as benefiting from the JP reference's method of mixing are evaluated, there is no teaching or suggestion of the compositions of the now pending claims. In particular, while Table I (p.25) illustrates examples using R32 with R600a (isobutane), no R125 is used. While Table II (p.32) provides an example of the combination of R134a and R125, only n-butane is used and used only in the range of from 1.25 wt % to 2 wt. %.

In addition, the only figure dealing with compositions having R125, R134a and R600a is Figure 4 and it does not provide any information that would teach or suggest the formulations set forth in the now pending claims. Rather, Figure 4 is a ternary vapor/liquid phase diagram for possible refrigerants including R134a/R600a mixed in an 80/20 % ratio, before then being mixed with R125. The R125 is described as being any amount, from 0% R125 to 100% R125. *See* paragraph [0112] and Figure 4.

Even assuming that there was a suggestion to combine Figure 4 with the compositional ranges suggest by the selection recited by the Examiner, the result is, at best, a teaching to use isobutane in the range of 5-10 wt. %. That is, using the Figure 4, which is specified at R134a/R600a weight percent ratio of 80/20, (aka, a ratio of 4:1) and if one were to fix the R134a at 20-40 wt. % (which is a larger range than the 26-36 wt % of '817 pending claims), the isobutane must be in a range of from 5%-10 % (i.e., $20 \div 4 = 5$ wt % R600a and

⁶ Using the Minitab® software, described *supra*.

40 ÷ 4 = 10 wt % R600a). The results are formulations outside the range of 3-4% isobutane as required by the compositions of the now pending claims.

In conclusion, after a fair and reasonable reading of the JP reference, there is nothing in the JP reference that would teach or suggest one of ordinary skill to formulate a refrigerant having a balance of advantageous properties, and nothing to suggest R125, R134a and R600a as specifically set forth in the now pending claims.

The Teachings and Suggestions of these Two References Combined
Do Not Provide a Basis for Selecting any Formulation

Both of the cited references ('868 and JP) disclose an extremely broad range of possible formulations and provide no assistance to the reader in selecting the narrow range of specific compositions required for a successful replacement for R22 refrigerant. The '868 patent attempted to combine refrigeration cycle calculations with actual system testing to support the '868 Example ranges of compositions. However, the actual system test results contradicted the cycle calculation predictions, leading the reader to the conclusion that the amount of R125 in refrigerant mixtures should have less than 60.5% R125. In sum, the '868 patent teaches away from the compositions of the refrigerant mixtures as now claimed.

The JP reference provides no helpful instructions, no performance calculations, nor test data for mixtures of R125/R134a/isobutane for replacement of R22. Rather, the JP reference deals only with a method of mixing. Consequently, even when combining the teachings and suggestions of the '868 patent and JP reference, the compositions as now claimed would not have been selected in circa 2002, without the benefit of hindsight from reviewing Applicants' pending patent application.

Unexpected Advantageous Balance of Performance and
Safety is Achieved by Claimed Compositions

Despite the global search for non-ozone depleting replacements for R22, suitable replacements remain elusive. As explained following, the compositions as now claimed represent a surprising and unexpected discovery of refrigerant blends that provide for a successful R22 replacement and achieves unexpected advantages. In particular, the now claimed compositions provide for a favorable balance of performance factors such as operating within the limits of equipment designed for R22 pressures and temperatures,

unexpected energy efficiency and cooling capacity near that of R22, and non-flammability safety under all leakage scenarios as required by ASHRAE Standard 34-2004, addendum p. *See Bivens Declaration*, paragraph 5 and Exhibit B.

Bivens' Exhibit B contains a summary of thermodynamic refrigeration cycle calculations and refrigerant vapor leakage scenarios for the compositions of the pending claims. A flame boundary plot of experimental data for mixtures of R125, R134a, and C3 – C5 hydrocarbons is also provided.⁷ From these data, one learns that over the range of the now claimed compositions, the compositions achieve similar cooling capacity and energy efficiency as R22, and are non-flammable under all leakage scenarios as required for evaluation by ASHRAE Standard 34-2004, addendum p.

The non-flammability of the now claimed compositions (having 3-4 wt.% isobutane) is unexpected in view of the Vapor Leak and flammability data obtained from testing '868 patent Samples. In particular, all nine of the '868 patent Sample compositions tested are flammable after some amount of leakage – even those with hydrocarbon amounts in the 2 -4 wt.% range. The now claimed compositions are not flammable – no matter how much vapor leakage has occurred from the original liquid composition. *See Bivens' Declaration* at paragraphs 5.1-5.2.

Moreover, the pending application 10/632,817 further notes at [0026] that the compositions are highly compatible with mineral oil lubricants, which is a property desired by the industry.

In addition, the now claimed compositions have a zero-ozone depletion potential ("ODP")⁸ and as can be seen from the calculated data provided in Bivens' Exhibit B, using the Cycle D thermodynamic cycle calculation software program available from the U.S. National Institute of Standards and Technology, the now claimed compositions have the

⁷ The Flame Boundary Plot, of Bivens' Exhibits A and B, was collected by E. I. du Pont de Nemours and Company ("DuPont") over many years, including experiments performed and data collected after 2003. This chart was not made available to the public by DuPont until about June 2006.

⁸ The ODP or Ozone Depletion Potential is measured for a single molecule of the refrigerant to destroy Ozone. All refrigerants use R-11 as a datum reference where R11 has an ODP of 1.0 compared with R22's ODP of 0.040.

following additional calculated favorable performance factors:

- low temperature glide⁹;
- suction pressure nearly equal to that of R22;
- lower discharge temperature than that of R22;
- energy efficiency rating that is substantially equal to that of R22;
- cooling capacity within 6% of that of R22; and
- slightly higher discharge pressure than that of R22, but within the system design limits.

As noted by Dr. Bivens, while Cycle D is a useful thermodynamic cycle calculation program, it does have limitations. For example, it does not provide the complete information needed to formulate a refrigerant with an optimum balance of safety and performance. Moreover, to the extent the thermodynamic cycle data that it provides is useful, the cycle data are determined only after a refrigerant formulation has been selected and its formulation entered into the software. Cycle D is not useful in identifying possible recipes of refrigerant formulations, (from the thousands of possible components) to meet a pre-selected specified performance criteria. Rather, it is used solely to provide Cycle data for the “pre-selected” recipe. Once the Cycle data is obtained, further research and development is performed.

In contrast to what the ‘868 patent teaches, the Applicants’ actual data is consistent with the Cycle D calculations, not in conflict. The pending ‘817 application has performance data for testing a mid-range of the claimed formulation in a compressor calorimeter system, as compared with that of R22. *See*, pages 4-5 of the ‘817 application, Tables 1, 2, and 4. The compressor calorimeter system is described on page 3 of the ‘817 application, section [0039] to [0044]. The system includes a compressor, oil separator, condenser, automatic expansion valve, and an evaporator, which allows for system design effects to be a factor in performance of the formulations now claimed versus that of R22. The system test data clearly show the “isobutane blend” of R125/R134a/R600a (64.9%/31.7%/3.4%) had favorable performance as a replacement for R22. The actual testing

⁹ Temperature Glide – is a term used to describe the temperature difference between the saturated vapor state and the saturated liquid state, at a constant pressure. Temperature glide occurs in near-azeotropic and zeotropic mixtures. At a given pressure, single component refrigerants boil or condense at a constant temperature, i.e., the saturated liquid and saturated vapor temperatures are the same (a temperature glide of zero). Refrigerant mixtures behave somewhat differently than single component refrigerants when they boil or condense. In the two phase regions of the system, such as the evaporator or condenser, liquid and vapor exist in equilibrium. For a refrigerant mixture at a given temperature or pressure, the compositions of the liquid and vapor phases are different, with the vapor composition having a higher concentration of the low boiling point components in the mixture. As a result of this compositional difference, refrigerant mixtures have measurable “temperature glide” when they boil or condense.

in the system is consistent with the favorable performance of the Cycle D calculation *See* attached as Bivens' Exhibit D, which is a graphical representation of the data of Table 2 (R22) and Table 4 ("isobutane blend").

In particular, the "isobutane blend" had an evaporator pressure within 5% of R22 (1.4 psia higher at 30 psia), 40 degrees C lower discharge temperature (which means lower thermal degradation effects on the system and the refrigerant/lubricant), energy efficiency of about 99% of R22, cooling capacity of about 94% of R22, and compressor discharge pressure of about 7% higher than R22. The Cycle D combined with the actual testing show that the "isobutane blend" and the other formulations as now claimed can be successfully used in existing R22 systems with minimal changes to the equipment and operating conditions. *See* Bivens' Declaration, paragraphs 5.4-5.5

In conclusion, the unexpected and favorably balance of properties (using the Cycle D data, flammability testing and analysis, and the actual testing described in the '817 application) is that the compositions as now claimed have the unexpected and advantageous balance of properties over the full range of compositions and are non-flammable.

CONCLUSION

In view of the above amendments, remarks and Bivens' evidence of unexpected results, Applicants respectfully submit that the application and Claims 42-53 are in condition for allowance. A Notice of Allowance is earnestly solicited.

Respectfully Submitted,
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